MODELLING KIDNEY-TISSUE DAMAGE IN SHOCK-WAVE LITHOTROPSY

K. Weinberg[a] **T. Colonius**[b] and **M. Ortiz**[a]

[a]Graduate Aeronautical Laboratories
California Institute of Technology
1200 E. California Blvd.
weinberg@aero.caltech.edu
ortiz@aero.caltech.edu

[b]Engineering and Applied Science
California Institute of Technology
1200 E. California Blvd.
colonius@caltech.edu

During shock-wave lithotropsy — a medical procedure to comminute kidney stones — the patient is subjected to hypersonic waves focused at the kidney stone. Unfortunately such shock waves also lead to damage in the kidney tissue. We present here a model for mechanical response of the tissue to the stresses state during lithotropsy.

The material model combines shear induced plasticity with irreversible volumetric expansion as induced, e.g., by cavitation bubbles. The theory bases on a multiplicative decomposition of the deformation gradient and on an internal variable formulation of continuum thermodynamics. By the use of logarithmic and exponential mappings the stress update algorithms are extended from small-strain to the finite deformation range. In that way the time-discretized version of the porous-viscoplastic constitutive updates is described in a fully variational manner.

By numerical studies we demonstrate the shock-wave propagation into the tissue and analyse the performance of the variational update. A first finite element simulation shows localized damage in the human kidney.